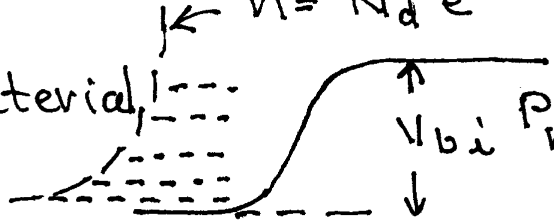
The Diode Equation

Consider a potential profile

$n = N_d e^{-(V(x) q/kT)}$

n material



V_{bi} p material

In equilibrium

electron density	positive density	$np = n_i^2$
$= N_d = n$	$= N_A = p$	
$p = n_i^2/N_d$	$n = n_i^2/p$	$= n_i^2/N_A$

$$n \text{ (in p material)} = n_i^2/N_A = N_d e^{-\frac{V_{bi} q}{kT}}$$

Lower V_{bi} by applying a bias

$$n \text{ (in p material)} = N_d e^{-(V_{bi} - V) q/kT}$$

$$= n_i^2/N_A \; e^{+Vq/kT}$$

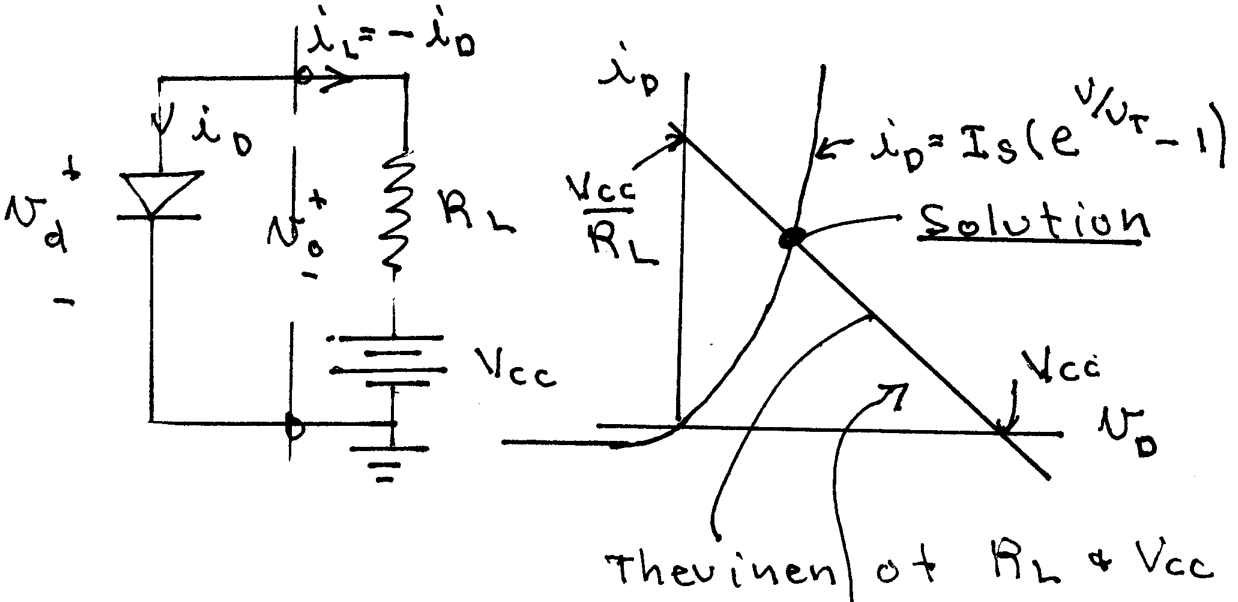
As we penetrate the p material the <u>excess</u> electrons exponentially combine

$$n(x) = n_i^2/N_A \; e^{Vq/kT} e^{-x/L_n} - n_i^2/N_A \left(e^{-x/L_n} - 1 \right)$$

$$\text{Current} = -(\text{Area}) \times D_n q \left.\frac{dn}{dx}\right| \quad (\text{At } x = 0)$$

$$= +A D_n q \, n_i^2/N_A \left(e^{qV/kT} - 1 \right)$$

Simple Diode Problem - Graphical Solution



$$v_o = v_D = i_L R_L + V_{cc}$$
$$= -i_D R_L + V_{cc}$$

or

$$i_D = -\frac{v_D}{R_L} + \frac{V_{cc}}{R_L}$$

Can find this numerically by successive approximations (Newton - Raphson for example)